CORONA DIVISION
NAVAL SURFACE WARFARE CENTER

A

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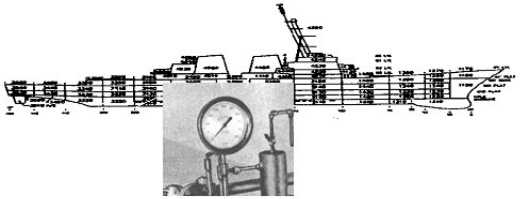
MAKING SEA POWER 21 A REALITY

SENSOR CALIBRATION FOR THE "NEXT NAVY" AND THE "NAVY AFTER NEXT"

- Calibration
- Why Calibrate?
- Prior MicroElectroMechanical System (MEMS) Shipboard Work
- Scope of Work Future Fleet
- Design for BIC MEMS Sensors
- BIC MEMS Sensor Concept Design
- What's Next
- Questions

Calibration Reminder



Portable Pressure Calibrator

NIST

Higher Accuracy Calibration Standard

NPSL

Why Calibrate?

- **Confidence in Measurement Results**
  - Gives Confidence in the Data Collected from Measurements
  - Support CBM & PHM
  - Systems Operation

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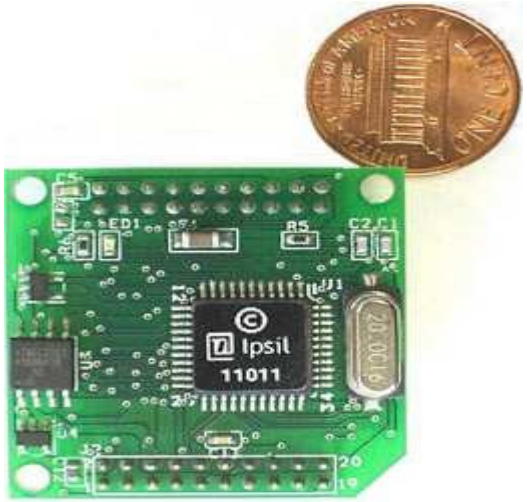
MEMS

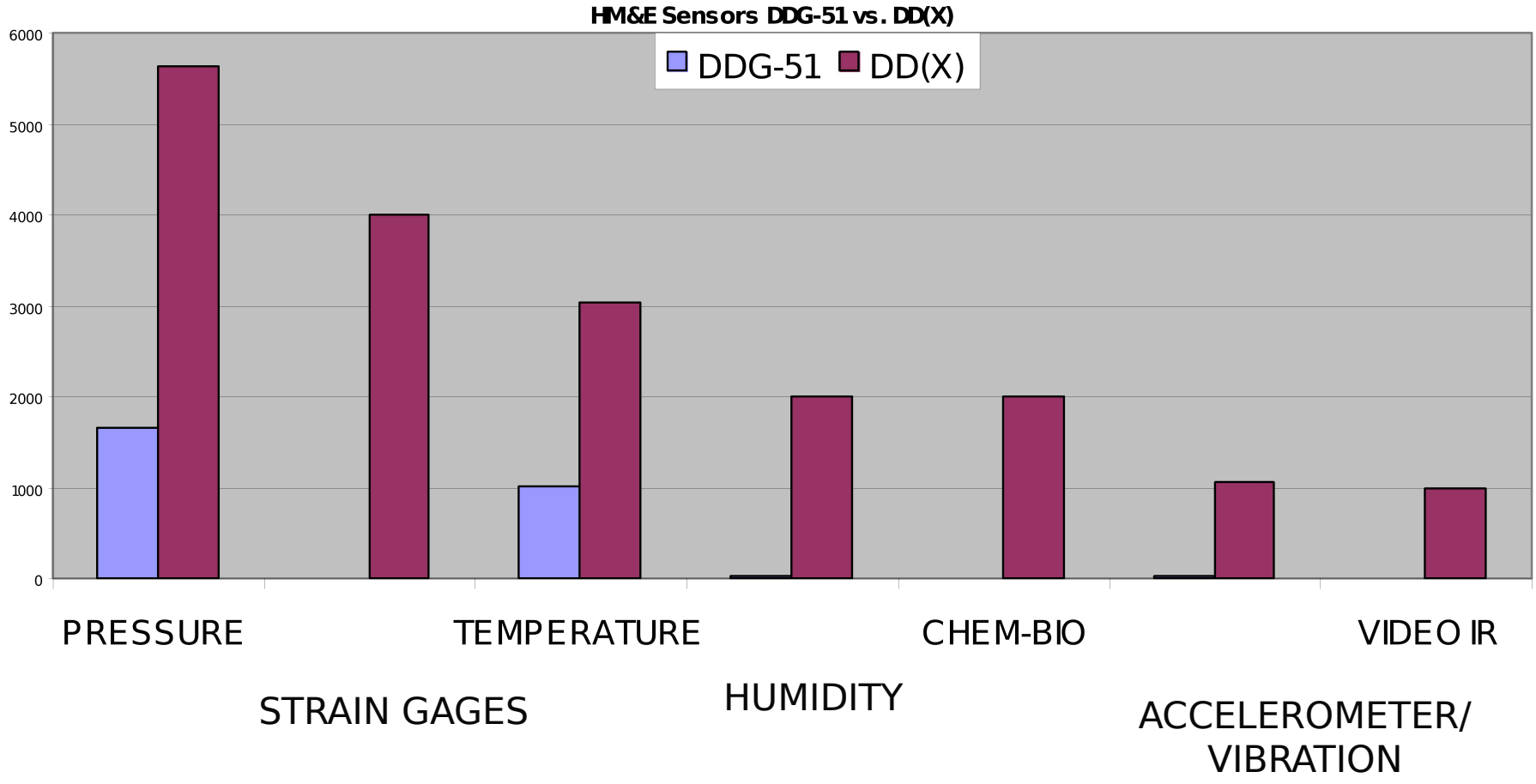
- **MicroElectroMechanical System (MEMS) Sensors**
  - Different Form & Fit, Same Function
  - Networked
  - Embedded into Machinery for Monitoring



MEMS based Pressure Sensor with Electronics package and Ethernet connection – Honeywell

Expected Shift in Sensor Application

(1998 data from NSWC Philadelphia)



RIMARY AREAS OF INCREASED SENSORIZATIO

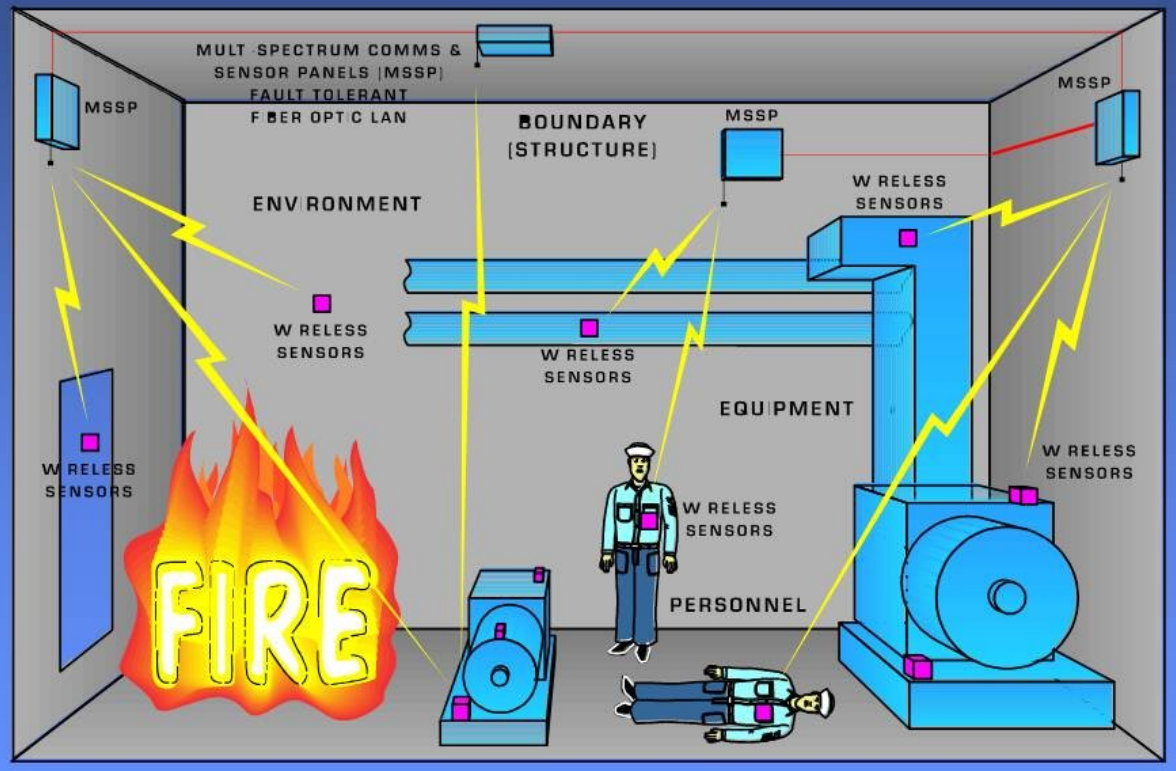
Other parameters

Prior Work for Wireless Sensor Networks

Reduced Ship Crew by Virtual Presence

POTENTIAL SENSING PARAMETERS

- ELECTRO-OPTIC/ INFRARED
- VIBRATION
- TEMPERATURE
- HUMIDITY
- CHEMICAL
- FLOODING
- PRESSURE
- ACOUSTIC
- STRAIN
- POSITION/ DEFORMATION



Scope of Work Future Fleet

- **~ 40,000 Below Deck Sensors (RCM est.) for Future DDG-51**
- **~ 8x for Future CVNX**
- **~ 10,000 Sensors for SSN/SSBN**
- **Future Fleet of 300 ships**
- **Using Current Calibration Methods**
  - 0.5 hr annually per Sensor

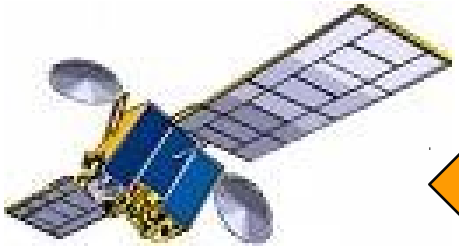
New Calibration Methodology

Paradigm Shift in Calibration Methods to Design of Sensors for *IN SITU* Network Based Calibration

- **Design of BIC MEMS Sensors**
  - Equivalent Methods for Calibration
  - Fully Automated, Network Based, Calibration
- **Affects Future Ship Design**
  - Choice of Sensors
  - Network Standard
  - Shipboard Standards for Traceability

Design for BIC MEMS Sensors

GPS



NIST

Sensors – Networked

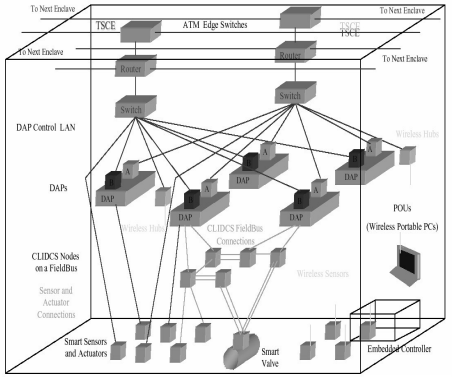
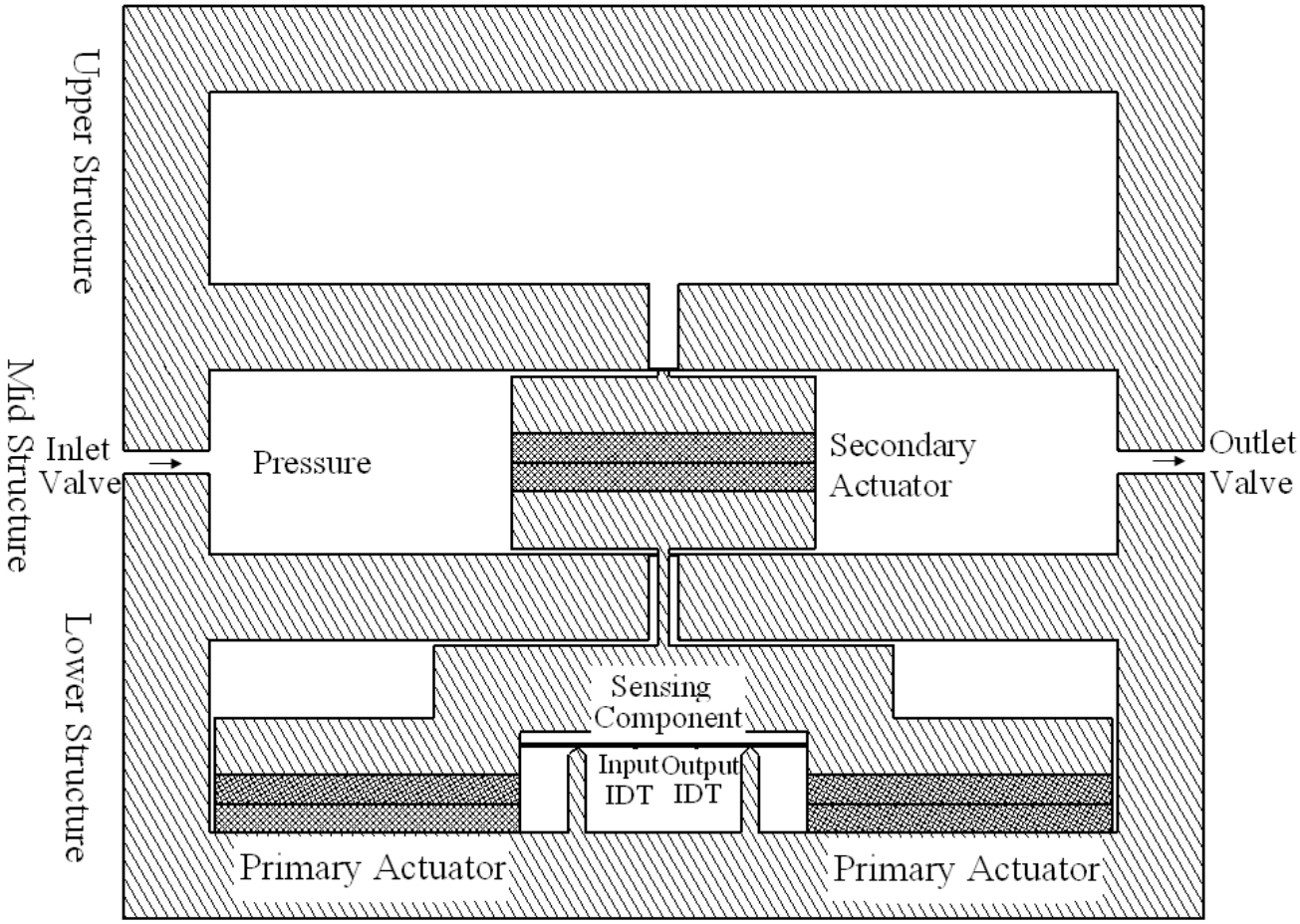


Fig 5: The Notional DD(X) Engineering Control System

BIC MEMS Pressure Sensor Design Concept



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Operations Video

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Benefit

- **Supports Future KPP Goal for Manning**
- **Calibration Capability for Embedded Sensors**
- **Automated Calibration for Networks of Sensors – Reduced Time, Cost, Manpower**
- **Increase Sensor Calibration Data**
  - Calibrate More Often
  - Automated Data Handling Through Shipboard MCMS Interface
- **Cost Savings**

What's Next?

- **Prototype Sensor**
- **Test & Evaluate**
- **Evaluate Network of Sensors** (LBES @ Philadelphia)
- **Concept Designs for Other MEMS Measurement Parameters**
- **Support**
  - Navy
  - Industry

QUESTIONS